U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1027

STRAWBERRY CULTURE

WESTERN UNITED STATES

THIS BULLETIN applies both to the western portions of the United States in which ordinary farm crops are grown largely under irrigation and to western Oregon and Washington where irrigation is not essential for strawberry production but may be profitable.

It describes methods practiced in the more important commercial strawberry-growing districts of the West; it aims to aid those persons familiar only with local and perhaps unsatisfactory methods, as well as inexperienced prospective growers.

The fundamental principles of the irrigation of strawberries are substantially the same as those of irrigating other crops. Details must necessarily be governed largely by the character of the crop grown.

Since strawberries in the humid areas frequently suffer from drought which causes heavy losses in the developing fruit, the information may prove suggestive to many growers in those areas who could install irrigation systems at small expense.

This bulletin gives information on soils and their preparation, different training systems, propagation, planting, culture, the leading varieties, harvesting, shipping, and utilization.

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STRAWBERRY CULTURE: WESTERN UNITED STATES

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CONTENTS

REGION TO WHICH THIS BULLETIN APPLIES

THE PRACTICES discussed in this bulletin apply to that part of the United States west of the one hundredth meridian, as shown in Figure 1. In most of this region strawberries must be grown largely under irrigation to make their production reasonably sure. In addition there is included a comparatively small though relatively important area in the western part of Washington and Oregon and in northwestern California where the rainfall is sufficient to raise strawberries without irrigation.

Along the Pacific coast, and to a slight extent elsewhere in this region, strawberries are grown for the general markets of the Western and Middle Western States, and even for Eastern markets. The largest centers of commercial strawberry production for the fresh-fruit market in the part of the country here considered are in Los Angeles and Orange Counties in southern California; in the Santa Clara Valley, south of San Francisco; and in the Hood River Valley, Oreg., with a considerable number of carloads produced in other localities. The Willamette Valley of Oregon and the Puget Sound district of Washington are also important commercial centers, the crop from these districts being used largely by canneries and by the barreling industry.

The practices followed in growing strawberries in the semiarid regions of the West are quite different from those in the Eastern States.[1]

[1] See Farmers' Bulletins 1026, Strawberry Culture: South Atlantic and Gulf Coast Regions; 1028, Strawberry Culture: Eastern United States; and 1043, Strawberry Varieties in the United States.

CHOOSING THE SITE FOR A PLANTATION

In choosing the site for a strawberry plantation in the Western States, the grower must consider the factors of moisture and alkali, as well as accessibility to markets, transportation facilities, and labor supply.

The moisture supply, either throughout the entire year or for certain long periods, is less than that needed for the production of strawberries. Because of this, except in western Oregon and Washington and in the extreme northwestern part of California, strawberries can be grown commercially only where water for irrigation can be supplied when it is needed.

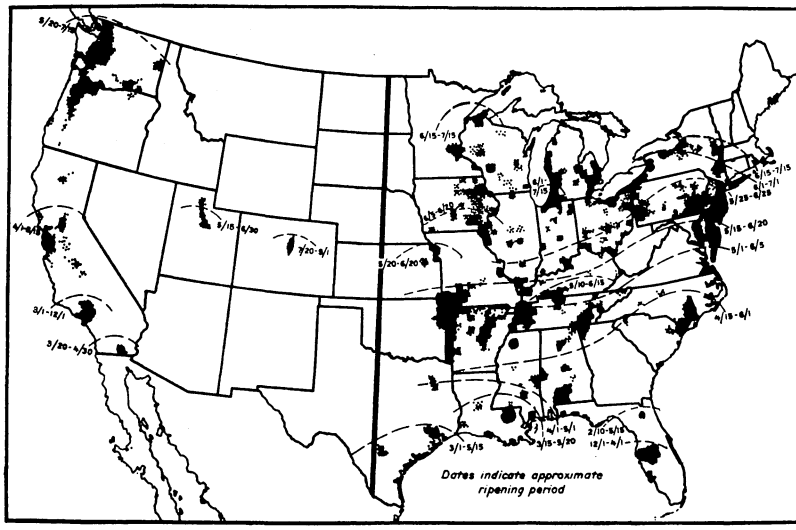

FIGURE 1.—Outline map of the United States, showing the important strawberry-producing areas with approximate shipping seasons. The region to which this bulletin applies is west of the heavy line from North Dakota through Texas

Much of the soil in this region contains alkali, and irrigation brings alkaline salts to the surface in such quantities that the strawberry plants are injured or even killed outright. Usually the first indication of alkali injury is the burning, mottling, and yellowing of the leaves in the lower spots in the field, but plants may be killed outright without the yellowing or mottling. Sometimes it may even pay to skim off the upper inch or two of soil where the alkali has come to the surface. In selecting a site for a strawberry field, those places where the soils are known to contain alkali should be avoided.

It is obvious that a community provided with good railroad service, refrigerator cars, and icing stations is in a very much better position to deliver strawberries in good condition to distant markets than one located only a comparatively short distance from a large center of population, but without readily available means of transportation.

Where strawberries are grown near large towns and cities the local demands may be largely depended on to absorb the supply of fruit. The improved highways in many States and the use of autotrucks

have materially increased the distances over which fruit may be transported by private conveyances to local markets. On the other hand, many locations admirably adapted to strawberry growing so far as natural advantages are concerned are quite impossible from a commercial standpoint, because they lack the necessary means of transportation by which the fruit can be delivered to the markets in good condition.

The accessibility of supplies, such as berry boxes and crates, is closely related to the available transportation service. In this respect, as well as with regard to the advantages of shipping in carloads, a location for commercial growing in which there are large strawberry interests is usually much to be preferred to one without such community interests.

The prospective strawberry grower must take into account very fully the means of getting his fruit to the consumer if he is to avoid failure even after his crop has been produced successfully.

The care of a strawberry plantation in irrigated areas ordinarily takes the time of one man for each acre up to the picking season, and one man for each 4 or 5 acres under intensive cultivation in nonirrigated regions. During the harvesting season additional help is necessary. The amount of such help varies with the size of the crop, but usually from 6 to 10 pickers per acre are needed. In some localities growers have found difficulty in procuring labor to pick their crop, and have encountered severe losses on this account. Therefore, before starting the production of strawberries on any large scale, an adequate supply of labor from year to year should be assured.

PREPARING THE SOIL

The preparation of land for planting strawberries should be complete and thorough. Any neglect or failure in this operation before setting the plants is likely to prove costly later. If the soil is not abundantly supplied with humus, it should be supplied with it before planting, either by making adequate applications of manure or by growing and turning under one or more green-manure crops, preferably a legume, such as clover, cowpeas, or some other crop adapted to the locality.

TWO-YEAR PREPARATION OF SOD LAND

The preparation of the soil may need to begin the season before, or perhaps two seasons before the plants are set. The latter is true of sod land, particularly where white grubs are troublesome. These grubs are the larva of May beetles, or June bugs, which frequently are abundant in sod land, where the eggs are commonly laid. If strawberries are planted on land infested with large numbers of white grubs the pests will eat the roots and cause a heavy loss. Since white grubs remain in the soil in the worm or larval stage for about two years and because the grass roots in the sod might interfere with suitable preparation of the soil, sod land usually should be devoted to hoed crops for two seasons before it is planted to strawberries. During this period the humus content can be renewed by proper management, if desired. Because of danger of injury by diseases occurring on tomatoes, potatoes, beets, and peas, and of injury from root aphis following corn, strawberries should

not ordinarily follow these crops. Grain crops, alfalfa, sweetpotatoes, and some of the green-manure crops are considered better to precede strawberries. If alfalfa is used it may be best to grow some grain or cultivated crop after the alfalfa for at least a part of a season until the alfalfa roots are decomposed.

PREPARATION FOR IRRIGATION

Land that is to be irrigated must be leveled or contoured and furrows made to convey the water through the field. Unless the field is level or the slope even, water will collect in depressions, flooding some plants while others do not receive enough water. In most sections the plants are either set on raised beds or the beds are raised after the plants are set. The width of these beds ranges from slightly more than a foot to several feet. If the soil is of a type that permits the water to percolate so that the whole bed is moistened readily, or if the subsoil is compact so that the water has time to penetrate laterally, wide beds may be used; if the soil is of a type through which the water percolates with difficulty, the beds must be much narrower. They should be raised from 2 to 12 inches above the furrows, according to the necessity for drainage.

By plowing, grading, and harrowing, the field should be put into such condition that it can be easily irrigated and thoroughly drained, and the tilth should be similar to that desired for a vegetable garden. Figure 2 shows the character of the beds on which the plants are set and the furrows between the beds as they appear in different sections. In Figure 2, A, C, and D, the plants were set on the level and the beds made after the runner plants began to root. In Figure 2, B, the ditches were made before planting.

In most localities the furrows used for distributing irrigation water are very shallow, as shown in Figure 2, A, C, and D, and in Figure 3, A. Where such furrows are used, the preparation of the soil will include such grading and leveling as are necessary to provide for ease in irrigation when the furrows are finally made.

VARIETIES

Only a very few varieties of strawberries are grown extensively throughout the entire semiarid region to which this bulletin applies. These varieties are listed in Table 1.

In the western parts of North Dakota, South Dakota, Kansas, Nebraska, and Oklahoma very few strawberries are raised, but the Dunlap is perhaps as promising as any variety wherever conditions offer any promise of success. In western Texas the Klondike is commonly grown.

New varieties should be tested carefully before large areas are planted to them.[2] Just as the varieties grown at present have supplanted those formerly grown because they are superior in some important characteristics, so other varieties will probably be developed and in turn will supplant those now popular.

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[2] Farmers' Bulletin 1043, entitled "Strawberry Varieties in the United States," showing the varieties grown in all parts of the United States, will prove suggestive to those interested in testing varieties.

OBTAINING PLANTS

Whether plants for setting should be raised locally or procured from some other section depends in part on the diseases that might be present on the plants and in part on their need of a cool, dormant-weather period. Growers in central California usually obtain their plants from northwestern nurseries; the southern California growers

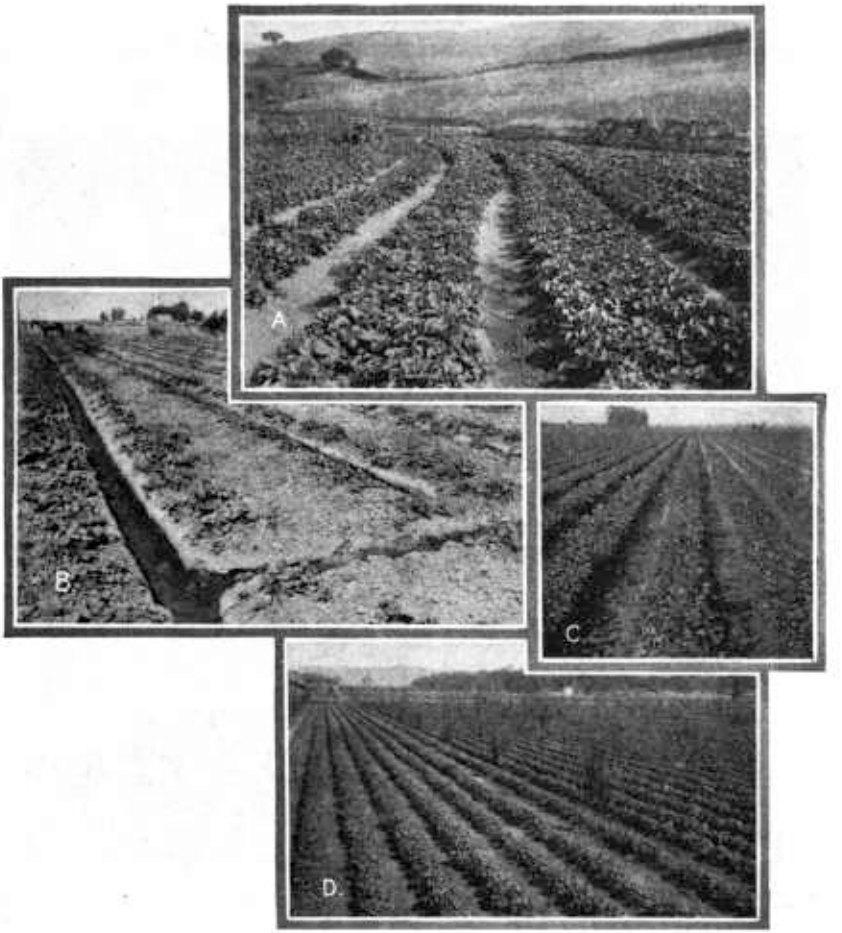

FIGURE 2.—A.—A field of strawberries in which the furrows and beds were made to follow the contour of the land. The beds are here relatively wide, as the soil is sufficiently porous to allow the water to percolate to their centers. (Photographed at Watsonville, Calif., Sept. 5.) B.—Strawberries under surface irrigation. The ditches are 8 feet apart and about 12 inches deep. The beds were made before the plants were set. A row of plants is set on each side of the ditch, and the new plants are allowed to make a spaced or matted row. (Photographed at Florin, Calif., in August.) C.—A field of strawberries in which the plants were set on the level and the furrows made after the plants were set, partly when irrigation was first needed and partly later. The beds are about 6 inches higher than the furrows and are 3 feet apart from center to center. The two rows on each bed are 12 inches apart and the plants in the row 6 inches apart. (Photographed at Moneta, Calif., Sept. 9.) D.—A field of strawberries with furrows only 3 or 4 inches below the beds and plants set in hills 18 inches apart; the beds are about 2 feet from center to center. (Photographed in the Santa Clara Valley, Calif., Sept. 2)

obtain their supplies from eastern growers. It is usually safer to get plants from nurseries located in regions where the ground freezes at least moderately, because the strawberry needs some dormant period in order to start the most vigorous growth.

Strawberries are propagated chiefly by the use of runner plants; and where diseases are not serious and where there is sufficient cool weather in winter to provide a rest period, each grower can easily raise his own stock from his bearing plantation. The vigorous

FIGURE 3.—A.—A field of strawberries planted without furrows, to be grown in hills. The rows are 32 inches apart and the plants in the rows 12 inches apart. Shallow furrows will be made between the rows when the plants need irrigation. (Photographed at Hood River, Oreg., July 30.) B.—Rows of young strawberries growing in hills. The plants were set, after the first rain in November, 1 foot apart in rows 3½ feet apart, and all runners were removed as they appeared. (Photographed at Santa Rosa, Calif., Aug. 31)

younger plants along the sides of the matted rows can be used for this purpose. These plants develop and take root during the summer and autumn, and are more likely to start a vigorous growth after transplanting than the older plants that are ready to start fruit bearing. In digging plants the roots of those left should be disturbed as little as possible.

TABLE 1.—*Extensively grown strawberry varieties, arranged by States and districts*

An asterisk (*) before a name indicates that the variety is recommended for commercial planting. Varieties without an asterisk are grown more or less in the States and districts listed, but are not considered so desirable for commercial planting as the others]

State and district	Varieties	Remarks
Arizona:		
Throughout the State	*Klondike	
	St. Louis	
	Missionary	
California:		
Fresno	*Marshall (*Oregon, Banner*)	
Los Angeles	*Klondike	Spring crop only.
	Missionary	Do.
Sacramento	*Marshall (*Oregon, Banner*)	
San Francisco	——do	
	*Nick Ohmer	For shipment to the East.
	Capitola	
Throughout the State—		
North of Fresno	*Nick Ohmer	
	*Marshall	
South of Fresno	*Klondike	
	Missionary	
	Blakemore	New variety for trial.
Colorado:		
Throughout the State	*Dunlap	For early season.
	Jucunda	For late season.
Idaho:	*Superb	Everbearers.
Throughout the State	Progressive	Everbearers.
	*Glen Mary	For local market.
	Marshall	For local market.
Montana:		
Throughout the State	*Dunlap	
	*Progressive	Everbearer.
Nevada:		
Throughout the State		Utah and California varieties should be tried.
New Mexico:		
Throughout the State		Colorado and Arizona varieties should be tried.
Oregon:		
Hood River	*Clark	For shipping and frozen pack.
Throughout the State	*Gold Dollar	For early local market.
	*Marshall (*Oregon*)	For midseason local market and frozen pack.
	Ulrich (*Improved Clark*)	New variety.
	*Rockhill	An everbearer.
	*Ettersburg 121	For canning. Clay soils only.
	*Corvallis	For canning. Valley soils.
	*Wilson	For rich soils and canning.
	*Redheart	For canning. All soils.
	*Narcissa	New variety for trial to replace Marshall.
Utah:		
Throughout the State	*Marshall	
Washington:		
White Salmon and Kennewick	*Clark	For shipping.
Puget Sound	*Marshall	For general use.
	Magoon	
	Gold Dollar	For early market.
	Narcissa	New variety for trial to replace Marshall.
	Ettersburg 121	For canning. Clay soils only.
Spokane	Glen Mary	
	Marshall	
Wyoming:		
Throughout the State	*Dunlap	
	Bederwood	

TIME OF PLANTING

In most localities the season of planting will depend upon the period of greatest rainfall, although it is not necessary to rely so largely on rainfall where irrigation is used. As the period of rain-

fall is usually in the winter in California, Oregon, and Washington, growers in those States generally set their plants during the winter or spring, according to the conditions in the different areas. In most parts of California late fall and early winter are preferred, for, if the plants are set in November or December and make a good growth during the winter, considerable fruit may be harvested during the following summer. On sandy soils the plants can be set at almost any time during the winter, but on heavy soils they should be set just after the first rains. If the heavy rains occur before the planting is finished, however, the soil under most California conditions is in such poor condition for working that growers generally prefer to wait until early spring to set the remainder of the plants.

There is evidence that in California the yellows disease of the Marshall (*Banner, Oregon*) spreads chiefly in the winter and that if planting is done as late as May there is less of this disease than when the plants are set in the period from December to April 15. Where planting can be done late, this fact should be considered.

In western Oregon and Washington and in other northern parts of the irrigated areas early fall or early spring planting is preferred by most growers, for the cold is likely to injure late fall-set plants which are not fully established. In southwestern Texas the plants are often set in early fall, and a crop is harvested the following spring.

PLANTING AND TRAINING SYSTEMS

Two general systems of planting and training strawberries are used—the hill system and the matted-row system.

When strawberry plants are to be grown under the hill system, they are commonly set 12 to 36 inches apart in the row, all runners being removed as they appear; or they are set 3 or 4 feet apart and the runner plants rooted at definite intervals between the mother plants. Figure 3, A and B, shows fields trained to this system, which is widely used throughout the irrigated regions of the United States as well as in the South Atlantic and Gulf Coast States and under overhead-spray irrigation in the Northwestern States.

Under the matted-row system, plants are set from 18 inches to 4 feet apart in rows, and part or all of the runners which appear are allowed to root. Perhaps the most common practice in irrigated regions is to allow each plant to make a definite number of new runner plants. These plants are spaced from 6 to 12 inches apart and all others are removed as fast as they develop. Spacing is done by covering the tips of the runners with earth as soon as they begin to enlarge, or by setting young runner plants. Figures 2, A, and 4, A, also 12, A and B, show fields of strawberries grown under this system.

Both the hill and the spaced matted-row systems are used extensively in irrigated regions. The most suitable system will depend on local conditions. Where the soil is heavy and rather impervious to water, narrow beds must be made and the hill system should be adopted. Where the soil is penetrated readily and to some distance by irrigation water, the beds may be wider and the spaced matted-row system may be used. One advantage of the matted row is that

the beds are wider and there are fewer furrows to care for. Both systems, however, depend on intensive cultivation for the best results, and if sufficient labor is available, one or the other should be used. Where labor is not abundant and it is not desirable to use the most intensive methods, a matted row in which the plants are not spaced may be used. This system, however, is rarely adopted in irrigated regions.

In the Los Angeles district of California, where the double-row hill system is used, the plants are set at intervals of 4 feet in rows 3 to 3½ feet apart. Runner plants are so spaced that two rows about

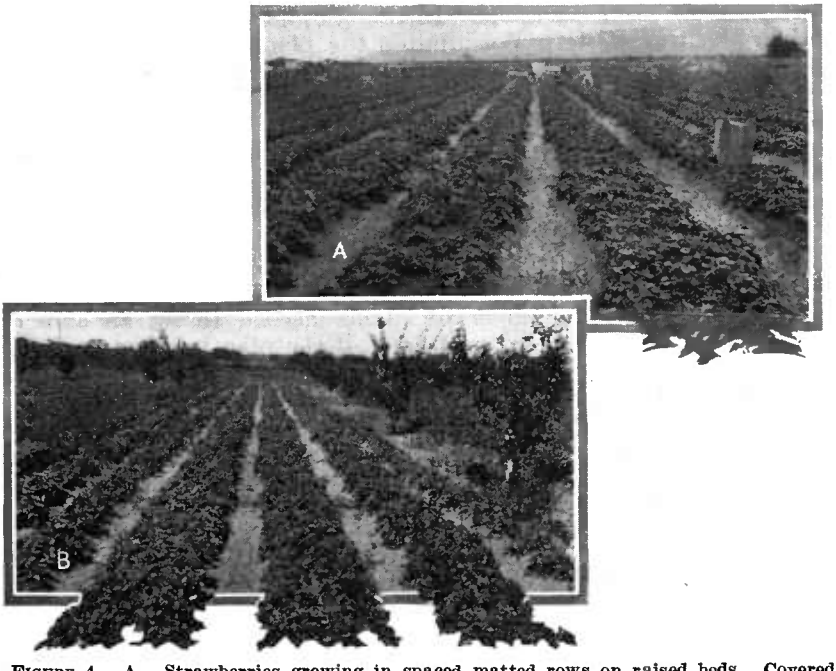

FIGURE 4.—A.—Strawberries growing in spaced matted rows on raised beds. Covered carriers for receiving the picked fruit are shown. (Photographed at Watsonville, Calif., Sept. 6.) B.—Strawberries grown in double rows under the hill system. The plants are 8 inches apart, the two rows 14 inches apart, and the furrow between the beds is 28 inches wide. (Photographed at Santa Clara, Calif., Sept. 4)

12 inches apart, with plants at intervals of 6 to 12 inches, finally occupy each bed, as shown in Figures 2, C, and 4, B. This system is used in many other districts and is one of the best wherever conditions permit its adoption.

In the counties just south of San Francisco the plants may be set in accordance with the hill system, 18 inches apart in rows 2 feet apart, as shown in Figure 2, D, or 1 foot apart in rows 3½ feet apart, as shown in Figure 3, B. However, the double-row system is common; under it the rows are 12 to 14 inches apart with an alley about 28 inches wide between the beds, as shown in Figure 4, B. The spaced matted-row system, as shown in Figures 2, A, and 4, A, is probably the one most generally used in this section. The beds are 2 to 3 feet wide and the furrows 1 to 2 feet wide. When this system

is used the usual custom is to set two rows of plants on each bed next to the edges. The runner plants are then spaced 6 to 8 inches apart as they develop.

In the Sacramento district of California the spaced matted-row system is commonly used. The beds are made 6 to 9 feet from center to center. The plants are set about 18 inches apart along both edges of the furrows (fig. 4, A), and a spaced matted row along each side is formed from the runner plants. (Figs. 2, A, and 12, B.)

In the Hood River district of Oregon and in the White Salmon district of Washington the hill system illustrated in Figure 3, A and B, is used almost exclusively. The plants are set 12 to 18 inches apart in rows 30 to 32 inches apart. In the Willamette Valley of Oregon and in much of western Washington the plants are grown in hills, the plants being set 3 by 3 feet to allow for cross cultivation. In one test, however, much larger yields were obtained from plants 18 inches instead of 3 feet apart in the rows.

In other parts of the region to which this bulletin applies, both the hill and the matted-row systems are used, but the plans of setting and training are for the most part similar to those illustrated and described here.

NUMBER OF PLANTS PER ACRE

Table 2 shows the number of plants needed to set an acre of ground when spaced according to one of the planting systems commonly used.

If there is little danger of losing plants from any cause, only the number indicated will be needed. If there is danger of loss, a somewhat larger number should be procured in order to insure a full stand, as the expense of irrigating and caring for a field which has many blank spaces will be out of proportion to the value of the crop obtained.

TABLE 2.—*Number of strawberry plants required to set an acre of ground when spaced at different distances*

Distance apart	Plants to the acre	Distance apart	Plants to the acre
	Number		*Number*
2 feet by 1 foot	21,780	2½ feet by 1½ feet	11,616
2 feet by 1½ feet	14,520	3 feet by 2 feet	7,260
3 feet by 1 foot	14,520	3 feet by 3 feet	4,840
3½ feet by 1 foot	12,446	3 feet by 4 feet	3,630

CARE OF PLANTS BEFORE SETTING

When the plants are received from a nursery they are usually tied in bundles, as shown in Figure 5, A. Good plants usually have bright, light-colored root systems. When grown on very dark soil, however, the roots may be brown or yellowish in color. If the plants are at all dry upon arrival, the roots should be soaked in water for a few hours before planting or heeling in. If they can not be set at once, the bundles should be opened and the plants separated and heeled in, as shown in Figure 5, B. The soil packed about the roots of the plants should be thoroughly moistened.

The plants to be set should be protected from the sun and from drying winds while they are being distributed in the field, either by means of burlap or old sacks, or in some other effective way. An old fertilizer sack may be used for protecting the plants while dropping them. (Fig. 6, C.)

SETTING THE PLANTS

When furrows and beds are made in preparing the soil, they will show approximately the rows on which the plants are to be set. Care should be taken, however, to make the rows straight. The exact place for each individual

FIGUAE 5.—A.—Bundles of plants of the Klondike and Dunlap strawberries. Note that the Dunlap plants do not grow so large as those of the Klondike. B.—Heeling in plants until it is convenient to set them in the field. The bundles are opened, each plant laid by itself with the crown even with the surface of the ground, and the moist soil packed firmly against the roots

plant may be indicated by a row marker similar to that shown in Figure 7.

If the soil is very mellow, a place for the roots may be made with the hand, but in heavier soil a dibble or trowel (fig. 8) or the tools known as punch and tongs (fig. 6, A) may be used. One accustomed to their use can set 10,000 plants in eight hours, and experts can set a much larger number. Plant-setting machines are also used in this region; and their work is thought by some growers to be superior to hand setting.

Perhaps the most important points in setting plants are to place them at the right depth and to firm the soil thoroughly about the roots after they are set. If the plants are set too high or the soil is not sufficiently firm, they will dry out and die, whereas if they are set too low and the crown is covered with soil the plants may rot. Figure 6, B, shows plants set too shallow, too deep, and at the proper depth.

FIGURE 6.—A.—Punch and tongs commonly used in setting sweetpotato plants, and which may also be used advantageously in setting strawberry plants. A hole is made with the punch, and the plant is picked up with the tongs and placed in the hole. The punch and tongs are especially useful in mellow soils. B.—Strawberry plants set at proper and improper depths in the soil. The one at the left is too deep, the center one is properly planted, while the one at the right is not deep enough. C.—A fertilizer sack used in dropping the plants. A hole is cut for the user's head, a slit is made across one side, and the plants are placed in the bottom of the sack. This protects them from the sun and wind

CARE AFTER SETTING

FLOWER STEMS AND RUNNERS

If the plants are set in early spring, flower stems frequently appear in a short time. Unless the plants are thoroughly established in the soil these stems should be removed, as fruit production is too great a strain on plants not fully established. When a large number of runner plants are needed, the flower stems should also be re-

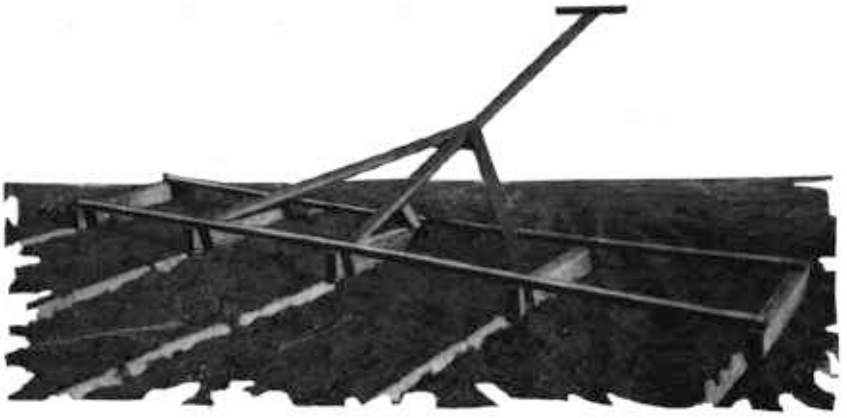

FIGURE 7.—A homemade marker for indicating where the rows of plants are to run. This marker is drawn by hand

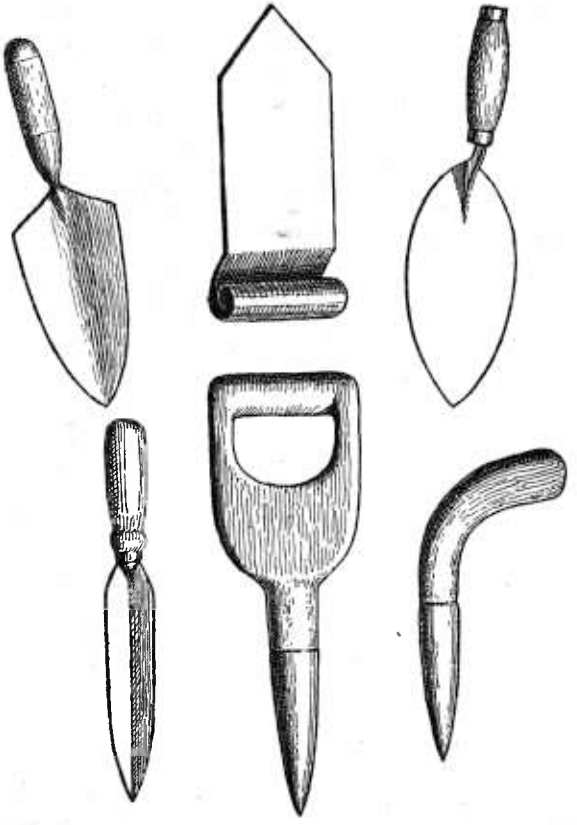

FIGURE 8.—Types of trowels and dibbles used in setting strawberry plants. The center implement at the top is considered the best under most conditions

moved, as this will increase the number of runner plants that are made.

When all the runners that develop are allowed to root without any restrictions, too many plants form in the matted rows, and some means should be taken to thin them. Plants in matted rows should be at least 6 to 10 inches apart, and, when necessary, they should be thinned with a hoe or by hand in order to prevent overcrowding.

When the plants in the matted row are spaced, the strongest runners are selected. As soon as the tip of a runner has enlarged and a leaf appears, it is covered with soil. Each runner is thus made to take root at a predetermined distance from the parent plant and from adjoining runner plants. Sometimes a large number of runner plants are made to root, either in distinct rows, as shown in Figure 2, C, or at a distance of about 7 or 8 inches from each other. (Figs. 2, A and B, 3, B, and 12, B.) If the runner tips can not be properly spaced, they may be left until well rooted and then reset in the proper space. All runners except those to be used are removed with a hoe, knife, or runner center, or in some other way.

The production of runners and the development of runner plants constitute a severe drain on the mother plant. Therefore, when strawberries are grown in hills, as in most of the western United States, the frequent removal of runners is important. Runners will need to be removed more frequently the first year than in later years and from some varieties more frequently than from others. In Oregon and Washington runners need to be cut five to seven times the first year on the Marshall and six to ten times the first year on the Ettersburg 121; in the second and following years two fewer cuttings probably will be sufficient.

Tests have shown that under some conditions plants with runners removed every two weeks produced 75 per cent more fruit than those with runners removed every six weeks. Under many conditions frequent removal is even more important than indicated by these tests. In still other tests plants were allowed to make runners after September 1. An average of only 4.5 runner plants per mother plant was produced after that date, but the yield of the mother plants was reduced to less than half that produced by adjacent plants on which no runners were left.

Runners may be removed with rolling disks attached to both sides of a cultivator or with runner-cutting tools. Figure 9 shows a circular cutter made from the blade of an old saw, and Figure 10 shows a cutter made somewhat like a sickle, which is used extensively where berries are grown on raised beds. Where the rolling disks will do good work they should be used. The other tools are effective under some conditions, but involve hand labor.

TILLAGE

Tillage is practiced to conserve moisture, to aerate the soil, and to keep down weeds. It should begin soon after the plants are set, and should be continued during the growing season. As soon as possible after each irrigation the irrigation furrows should be cultivated. This leaves a dust mulch on the surface which conserves

moisture and helps keep the soil in good condition. If the furrows are not cultivated, the soil may become water-logged and shrink on drying so that large cracks appear. (Fig. 4, A.) These cracks not only increase the loss of water by evaporation, but may even break the roots of the plants. One-horse cultivators are usually run through the furrows, and hand hoes or rakes are used on the beds. Horses are little used during the fruiting season in central California, because of the injury they and the cultivators do to the fruit.

FIGURE 9.—A strawberry-runner cutter to supplement the rolling disk on the cultivator or, under some conditions, to be used instead of the disk. The blade of this cutter was made from an old crosscut saw. The lightest weight saw blades should be used

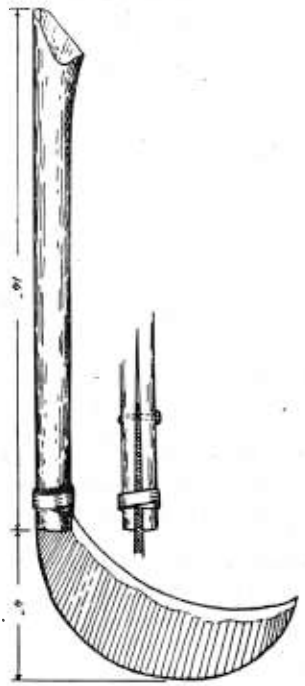

FIGURE 10.—A sickle knife much used in California by the Japanese to cut runners and to trim old leaves

MAINTAINING THE SOIL FERTILITY

The use of stable manure and fertilizers on strawberry fields is governed largely by the same principles that apply to other crops. As soils differ greatly in their composition, the use of fertilizers is usually determined by each grower according to his own conditions. Fertilizer requirements can be determined by applying the different plant foods, nitrogen, phosphoric acid, and potash, both separately and in different combinations, and in different quantities, to small plots of strawberries on which records of yields are kept. In like manner the effect of different applications of stable manure can be tested on small plots.

A good crop of berries will remove considerable quantities of nitrogen, phosphoric acid, and potash. Most western soils, except coarse sand, are so well supplied with these plant foods that large crops can be produced without fertilizers, provided the physical condition of the soil is good. Therefore, if the soil is kept in a satisfactory condition by the addition of humus and by adequate irrigation and tillage, many soils will need no commercial fertilizer or stable manure. In many localities, however, growers have found the use of fertilizers profitable, but the applications which can be made with the greatest gain differ with different soils and different soil conditions. Much can be done to insure productive plantations by seeing to it that the soil is in the best possible state of fertility before the strawberry plants are set out.

IRRIGATION

In all the region to which this bulletin applies, except a very small area in northwestern California and in that part of Oregon and Washington west of the Cascade Mountains, irrigation is necessary in strawberry production. In the area where irrigation is not necessary, recent experiments have shown that it may be profitable. At the Oregon Agricultural Experiment Station irrigation doubled the average net income from fields of the Marshall variety but not from fields of the Ettersburg 121. At least a part of the increased production of the Marshall apparently results from the larger plants in irrigated fields early in September when fruit-bud development for the following spring begins. Fruit buds in the Ettersburg 121 do not begin to develop until nearly November and after fall rains have caused a vigorous growth, therefore irrigation does not seem to be so essential with this variety. As most varieties grow like the Marshall, irrigation may be expected to give similar results.

Strawberries must have an ample supply of moisture, not only during the season when they are bearing fruit, but also throughout the growing season. As the root system is shallow, the surface soil must be kept moist and the irrigations must be more frequent than those required by many plants whose roots penetrate the soil deeply. The number of irrigations, however, will depend largely on the character and frequency of the tillage used in conserving moisture and on the type and condition of the soil. If the furrows are thoroughly cultivated as soon as moisture conditions permit after each irrigation, the number of applications of water is materially smaller than the number required when cultivation is neglected. In the lighter soils during the bearing season the fields may be irrigated as often as every four to six days, and in heavy soils every week or two. During the months when the plants are not fruiting, irrigation need not be so frequent as when the crop is developing, only enough water to keep them in a thrifty growing condition being necessary. This may mean irrigating as often as once each week, or only four or five times during the season. Growers consider it essential to irrigate as few times as possible the first year, in order to establish a deep root system.

During the fruiting period the usual practice is to irrigate immediately after each picking. Sometimes, when there is danger that

the water in the furrows may not be absorbed before the next picking, the field may be covered by two applications, alternate furrows being irrigated in turn. The pickers can then follow the unirrigated furrows when at work.

In California, especially in the Santa Clara Valley, the plants of some varieties produce fruit for several months, from late in March or early in April until September or October; sometimes even until December. In that State, therefore, water will be needed for bearing plantations through a much longer season than in States where only an early summer crop is produced.

THE STRAWBERRY AS AN INTERCROP

The strawberry is very often grown as an intercrop in orchards and vineyards in most irrigated regions. Where the water supply is under control of the grower and a sufficient quantity can be used

FIGURE 11.—Superb everbearing strawberries grown as an intercrop in an apple orchard. (Photographed at Jerome, Idaho, July 27)

to supply the trees and vines that are being grown for the permanent crop, and the strawberries as well, this plan is practicable. If properly managed, the strawberries should pay a large part of the expense for the care of the permanent crop until it comes into bearing. Figures 4, B, and 11 show strawberries as an intercrop in prune and apple orchards. In a few locations strawberries are used as an intercrop in cherry and pear orchards, and to a slight extent in orchards of other fruits. They are also quite largely used in vineyards, as shown in Figure 12. The strawberries are left until they become unproductive or the permanent planting needs the entire space.

In nonirrigated regions the interplanting of orchards with strawberries is inadvisable except under well-considered restrictions.

DURATION OF A PLANTATION

The length of time during which a strawberry plantation is maintained depends chiefly upon its productiveness. If the humus content is ample, so that the soil is in good tilth, and if diseases and insects are not troublesome, the plantation may produce fruit for several years. In California the crop is usually largest the second year. Large crops may also be obtained in some areas in the third

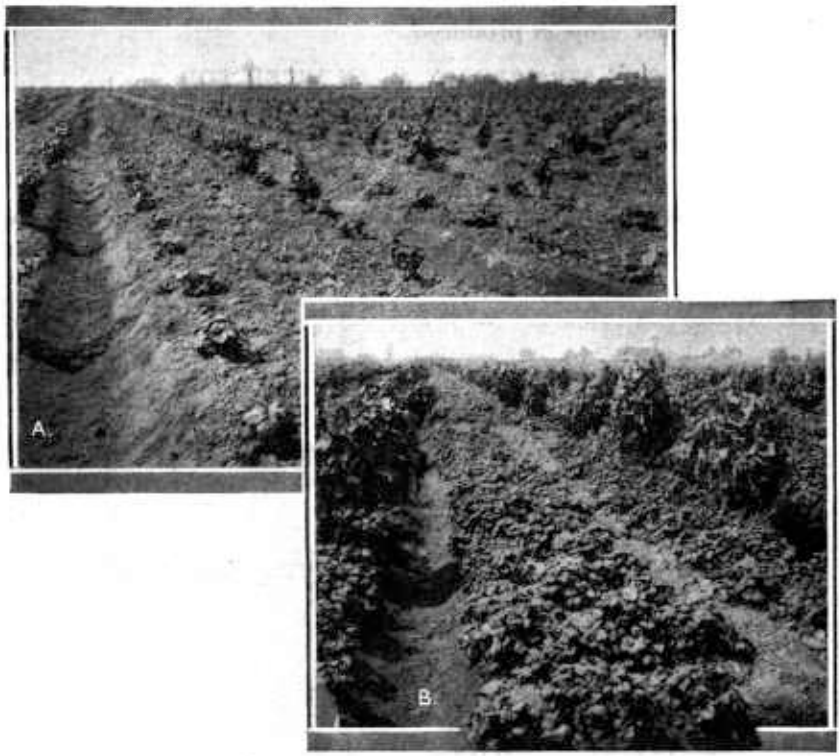

FIGURE 12.—A.—Strawberries interplanted in a vineyard. These plants were set about 18 inches apart along the edge of the furrows, which are 8 feet apart. (Photographed at Florin, Calif., Aug. 25.) B.—Another picture of strawberries interplanted in a vineyard. The plants are set when the grapevines are planted and furnish an income until the vines begin to bear. Four crops of berries are usually obtained before the plants are plowed up. The furrows are 8 feet apart, and the strawberry plants were spaced by hand on the beds. (Photographed at Florin, Calif., Aug. 25)

and fourth years, after which the plantations generally are discontinued. In other States the plantations are usually continued for three or four seasons.

RENEWING A PLANTATION

REMOVING TOPS AND OLD LEAVES

Frequently in Oregon and Washington, the tops of the plants are cut off at the surface of the ground, as soon as the crop has been harvested. This practice aids in controlling the crown borer and leaf diseases. Scythes, sickles, or hoes are used for cutting the tops.

The new growth starts out quickly, and the later care of such fields involves less labor than otherwise would be necessary. Figure 13 shows a field in which the foliage on some of the plants has been cut.

It is common in California to clean off all old and dead leaves, usually in December and January. This is done as a sanitary practice to help in the control of aphis and red spider and of fungi on rotting leaves that would rot the fruit in wet weather. Though laborious and expensive (costing $20 to $30 per acre), growers generally consider it worth while, not only to control pests, but to make the crop earlier and the berries larger. Some consider it better to pull off the old leaves rather than trim them, leaving the old leaf stems on the plant. Hand cutters similar to those shown in Figures 9 and 10 are used for this purpose.

FIGURE 13.—A strawberry field soon after the crop has been harvested. The tops of the plants at the right have been cut. (Photographed at Vashon, Wash., Aug. 7)

THINNING THE PLANTS

In the few places in the West, where the matted-row system is used, the plants are generally thinned immediately after the foliage has been cut. In some cases the rows are narrowed by plowing up a part of each side and the remaining plants are thinned with a hoe. In other cases two-thirds of the width of each row may be plowed up, including the plants which have recently produced a crop. Later in the season runner plants which develop are allowed to replace those removed. Thus the plants that have been weakened by fruit production are replaced by new and vigorous plants for the next season's crop.

HARVESTING AND SHIPPING

The harvesting season varies greatly in the different parts of the irrigated areas, being affected both by the climate and by the variety. In southern California the Klondike produces a heavy crop during March, April, May, and June, but yields little or nothing thereafter until the next season. The principal varieties grown in

central California usually produce continuously from April to June and to a lesser extent throughout the summer until October or November. Most of the berries ripening in the summer and autumn are shipped to local markets and to the East. In Oregon most varieties produce fruit only during the early summer months.

The main shipping season in most other districts is during the early summer only. In the Steamboat Springs district of Colorado the season is during July and August.

When intended for the general market, such packages as those shown in Figure 14 are used. In Oregon and Washington the 24-pint crate is in use, and in California the 12-pint crates for shipping and the 30-pint crates for local markets are employed. The chests still used in the districts near San Francisco are shown in Figure 15. Figures 16 and 17 show the various types of carriers used in picking. Carriers used by pickers in southern California are shown in the title-page illustration.

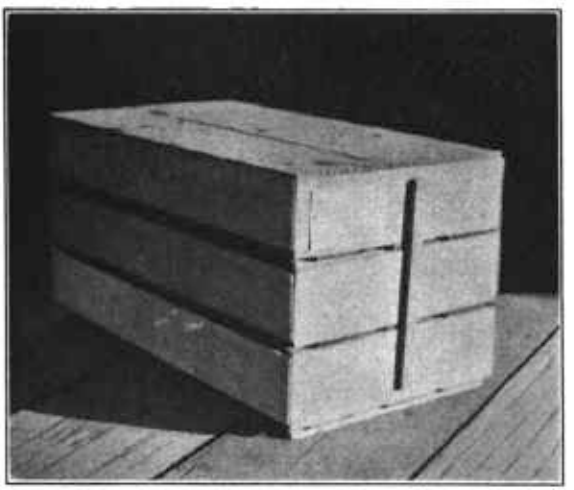

FIGURE 14.—Three 12-pint California shipping trays cleated together, five trays commonly being thus cleated for shipping

DISEASES

Yellows is a virus disease known from southern Oregon to southern California and affects chiefly the Marshall (*Banner, Oregon*) variety. It is most serious in the Santa Clara-Watsonville district, where losses have been so great that many growers have given up the Marshall and raise the Nick Ohmer instead. The disease is carried by aphids (plant lice) from plant to plant, especially during the months from October to April. The diseased plants never recover, and all runner plants from them have the disease, are dwarfed, and produce little or no fruit. (Fig. 18.) Using clean planting stocks, setting them as late as May 1, isolating fields from infested plantings, and roguing out diseased plants help to control the trouble.

Verticillium wilt and Rhizoctonia root rot are two known root diseases that injure or kill the plants and are especially injurious to strawberries grown after certain other crops that the root diseases also attack. Control measures, therefore, consist of proper rotation and in setting clean plants. Verticillium attacks the crown, causing a characteristic wilting and dying of the entire plant. The older leaves usually die first. Rhizoctonia attacks the young roots, causing sunken cankers that finally kill the plants. Affected plants are

weakened and dwarfed, produce correspondingly less fruit, and in severe attacks, die. The affected plants usually produce distorted leaves.

Verticillium is known to be serious in central California, where as much as 75 per cent of the plants may be killed outright the first year. It is most active in cool weather. Tomatoes are one of the most affected crops, and strawberries are often severely attacked when planted after this crop. Potatoes and raspberries are among the other common crops severely attacked.

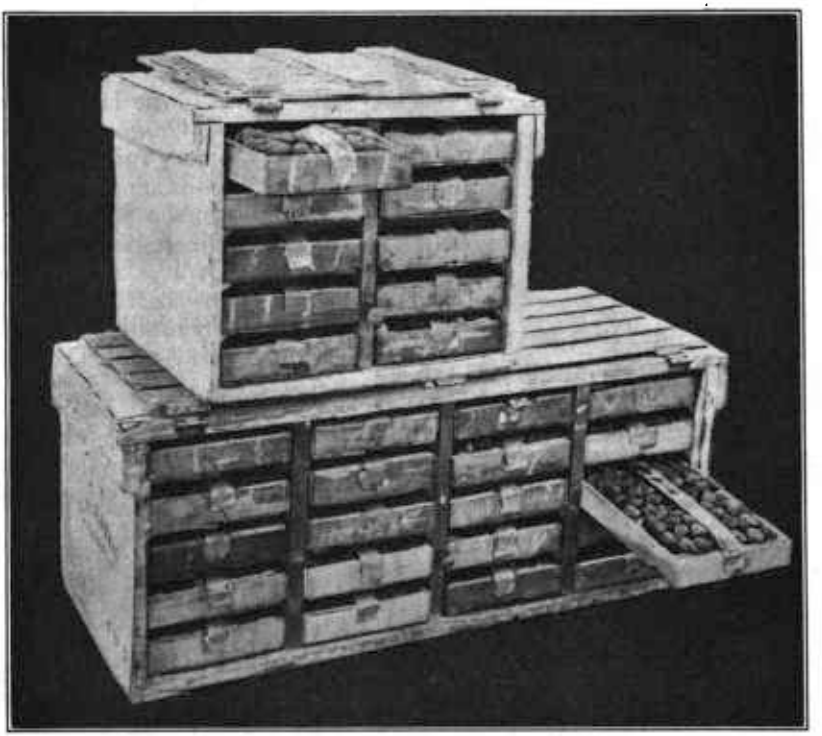

FIGURE 15.—A standard chest containing 20 trays, each holding six 12-ounce baskets of strawberries, with a half chest shown above. These are used to some extent for local-market shipments. (Photographed at Watsonville, Calif., Sept. 6)

Rhizoctonia is known to be serious in Oregon and Washington, where all plants in many fields are attacked. It is common everywhere on the bracken fern and on tomatoes, potatoes, beets, and peas.

In areas where these two diseases are injurious, fields in which tomatoes and potatoes have been grown should be avoided, and strawberries should be grown on fallow fields or those that have been in grain crops for a few years.

Dwarf disease, caused by a nema which lives in the crown of the plants, is frequently found in fields of the Klondike and other varieties in southern California. It dwarfs the plants, and the leaves are distorted and small. Its control consists in setting clean plants; if affected plants are found they should be taken out of the field.

INSECTS

The root weevils that have long been known in the eastern United States, where they are pests of minor importance, have become serious pests in British Columbia, Washington, and southward into the Willamette Valley of Oregon as far as Salem. New and satisfactory methods for controlling these pests with poison baits have been worked out.

The strawberry mite, widely distributed throughout the northern United States and Canada, has been found causing serious injury to the Mastodon everbearing and to the Clark and Nick Ohmer varieties, especially the Clark, in the Hood River Valley of Oregon and the Nick Ohmer and occasionally Capitola and Marshall varieties in the Santa Clara-Watsonville region of California. It has also caused some injury to the Missionary and Klondike varieties at one point near Los Angeles. Plants attacked by this mite are dwarfed, and in severe cases the entire crop is lost. Because it is difficult to rogue out all mite-infested plants, and no effective spray has been found, control of this pest lies in setting clean plants.

FIGURE 16.—A.—Strawberry carriers and trays used in picking. The tray that is filled contains six 12-ounce baskets of strawberries; one tray is partly filled and one is empty. (Photographed at Santa Clara, Calif., Sept. 4.) B.—Carriers used in taking the trays from the field to the packing house or chest. (Photographed at Santa Rosa, Calif., Aug. 31.)

The spittle bug, crown borer, crown miner, red spider, and other insects are often serious pests in parts of the western United States. The spittle bug, crown borer, and crown miner are more injurious

in Oregon and Washington and the red spider in California. The use of clean plants will help to control most insects.

The relation of white grubs to strawberry growing has been mentioned, and the common methods of avoiding serious loss from them have been given (p. 3).

Growers should write to their State experiment stations or to the Bureau of Entomology, United States Department of Agriculture, Washington, D. C., for information on control methods for strawberry insects.

UTILIZATION

Many million dollars' worth of strawberry products are manufactured each year. Among the more important are preserves, jams, conserves, essences for flavoring candies and for use as flavoring ex-

FIGURE 17.—A hand carrier for trays of strawberries. These covered carriers protect the berries from the sun while they are in the field. (Photographed at Watsonville, Calif., Sept. 6)

tracts, sirup for soda fountains, and crushed fruit for flavoring ice cream and sauces. Large quantities of strawberries are also canned. The varieties best suited for preserving are firm, light red, and with yellow seeds; an acid, firm-fleshed sort, deep red to the center and with a strong strawberry flavor, is best for canning. Among the best varieties for canning are the Corvallis, Redheart, Ettersburg 121, and Wilson. Both Corvallis and Redheart are new varieties which may replace the Ettersburg 121 for canning. The Clark and Marshall are liked best for barreling for the preserving and ice-cream trade. The Ulrich is a new barreling variety of some promise for the Hood River Valley section.

Many strawberry barreling factories have been erected in the large producing areas. Most of the preserving factories are located in the eastern cities and the fruit is shipped to them. The strawberry is in the best condition for use if picked while very firm, even before it is fully ripe, and barreled with sugar as soon as possible. In utilizing strawberries in the home or for the market the experience of these concerns in selecting certain varieties and using firm berries should be followed.

COLD STORAGE[3]

Fresh strawberries can be stored commercially only for very short periods. Ten days is the usual maximum storage period even when the berries are held at a temperature of 32° F. After about 10 days,

FIGURE 18.—In the foreground are plants of the Marshall (*Banner, Oregon*) dwarfed by the yellows disease; beyond, plants of a resistant sort. (Santa Clara, Calif.)

sometimes sooner, the fruit loses its fresh bright color, tends to shrivel, and deteriorates in flavor. At temperatures of 40° or above, loss from decay caused by fungi may become serious. Gray mold

[3] Prepared by D. F. Fisher, principal horticulturist, Bureau of Plant Industry.

rot, Rhizopus rot, and leather rot are the most common storage diseases of strawberries.

FROZEN PACK

The frozen-pack method is used to preserve large quantities of strawberries each year.[4] Frozen-pack berries are largely used for fruit sirups and crushed fruit required by the soda-fountain, ice-cream, baking, and confectionery trades and for making jams, preserves, and jellies. An increasing retail trade in frozen berries for dessert purposes is also developing. At the present time about 90 per cent of the frozen berries are packed in barrels, kegs, or 30-pound cans for the larger users. One-pound paraffined paper cups are generally used for the retail trade.

Most of the barrels or kegs used are coated with paraffin on the inside to prevent the berries from absorbing a woody taste. Some of them, however, are made of woods that require further treatment to prevent the berries from absorbing the taste of the wood. Enameled cans are used to avoid corrosion. All containers must be made as nearly air-tight as possible to preserve the color and flavor of the fruit. The barrels hold 450 pounds of berries and sugar when 2 parts of berries to 1 of sugar are used.

In preparing the fruit for frozen pack the berries are hulled, sorted, and washed, various types of washing machines being employed. Usually there is a water tank into which the berries are dumped for a brief period to loosen the dirt. They are removed from this tank by an endless conveyor belt which carries them under sprays of fresh water, and they are then delivered to inspection belts where they are allowed to drain and where the final sorting and grading are done. The berries are then run into barrels or other packages together with the desired quantity of sugar.

While it may be desirable to vary the proportion of fruit to sugar with different varieties of berries, depending on the particular use to be made of the fruit, the usual commercial proportion is either 2 or 3 pounds of berries to 1 pound of sugar. In packing the larger containers the berries and sugar are added in alternate layers to insure more thorough mixing. While it is being filled the container is usually jolted, either mechanically or by hand, to insure each berry being coated with sugar. After being filled, the barrels are headed and smaller containers are tightly lidded. They are then transferred to a freezing room as soon as possible. A temperature of 0° F. or below in the freezing room is desirable for barrels and large containers in order to quickly reduce the temperature of the large mass of warm fruit, to prevent fermentation and spoilage, and to freeze the fruit in the center of the barrel as quickly as possible. In the small-size containers, especially the 1-pound "consumer packages," satisfactory frozen products can be obtained by using a temperature of 15° for both freezing and storage. After the barreled fruit is frozen, a storage temperature of 15° is satisfactory. While it has been generally believed that very rapid freezing with special equipment is necessary, investigations by the U. S. Department of Agriculture have proved that it is not required, and that for some fruits it may

[4] See U. S. Dept. Agr. Tech. Bul. 148. The Frozen-Pack Method of Preserving Berries in the Pacific Northwest.

be less desirable than a more moderate rate of freezing such as may be obtained in most cold-storage plants.

From 40,000 to 79,000 barrels, each holding 450 pounds of strawberries and sugar, were preserved by the frozen-pack method in the Pacific Northwest during the years from 1927 to 1931. In comparison, the pack in small-size "consumer packages" was very small, only about 112,000 of these containers being packed in 1931.

The frozen-pack method is highly specialized and its problems are being intensively investigated by the Department of Agriculture. It is recommended therefore that the latest information be obtained from the department before large investments in the business are made.

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